APPLICATION

FOR

UNITED STATES LETTERS PATENT

Be it known that we, Frank J. Bottari, residing at 6 John Swift Road, Acton, Massachusetts 01720; Andrea C. Marble, residing at 358 Pine Street, Lowell, Massachusetts 01851; and Michele L. LaCourse, residing at 83 East Street, Pepperell, Massachusetts 01463 and being citizens of the United States of America, have invented a certain new and useful

A TOUCH PANEL WITH AN INTEGRAL WIRING HARNESS

of which the following is a specification:

Applicant: Bottari et al.
For: A TOUCH PANEL WITH AN INTEGRAL WIRING HARNESS

RELATED APPLICATIONS

This application is related to Application No. 09/169,391 filed October 9, 1998 entitled TOUCH PANEL WITH IMPROVED LINEAR RESPONSE AND MINIMAL BORDER WIDTH ELECTRODE PATTERN. This application claims priority of Provisional application Serial No. 60/179,874 filed February 2, 2000.

FIELD OF THE INVENTION

This invention relates to a touch screen panel with an integral wiring harness which eliminates the bulky and unreliable prior art external wiring harnesses associated with touch screen panels and lowers the cost of manufacturing touch screen panel assemblies.

BACKGROUND OF THE INVENTION

Touch screen panels generally comprise an insulative (e.g., glass) substrate and a resistive layer disposed on the insulative substrate. A pattern of conductive edge electrodes are then formed on the edges of the resistive layer. The conductive electrodes form orthogonal electric fields in the X and Y directions across the resistive layer. Contact of a finger or stylus on the panel then causes the generation of a signal that is representative of the X and Y coordinates of the location of the finger or stylus with respect to the substrate. In this way, the associated touch panel circuitry connected to the touch panel by a wiring harness can ascertain where the touch occurred on the substrate.

Typically, a computer program generates an option to the user (e.g., "press here for 'yes' and press here for 'no'") on a monitor underneath the touch screen panel and the conductive electrode pattern assists in detecting which option was chosen when the touch screen panel was touched by the user.

The application referred to above relates to an improved edge electrode pattern on the resistive layer of the touch screen panel. The instant application relates to an improvement in the prior art wiring harnesses attached to the touch screen.

There are typically four insulated individual wires, each extending along and around the edges of the touch screen panel to each corner of the touch screen panel where the insulation is removed and the wire is hand soldered to a terminal electrode on the panel at each corner of the panel.

One or more additional layers, usually tape, are often used to secure the wires to the edges of the panel and there may be an insulative layer between the wires and the edge electrodes of the panel to electrically isolate the wires from the edge electrodes.

The problem with such prior art devices are numerous. The solder joints are often not very reliable and create solder bumps on the smooth surface. Moreover, the act of soldering the ends of each wire to the corner electrodes can damage the electrodes or even crack the substrate of the touch panel. Also, this assembly process is labor intensive and hence costly.

To reduce noise, a tape may be place under the wires. Adequate noise protection, however, may not always be possible. Also, the assembled touch screen panel does not have a finished appearance. Instead, the taped on wires are readily noticeable and detract from the appearance of the touch screen panel.

SUMMARY OF THE INVENTION

It is therefore an object of this invention to provide a touch screen panel with an integral wiring harness.

It is a further object of this invention to provide a touch screen panel with an integral wiring harness which is more reliable than prior art touch screen panel assemblies.

It is a further object of this invention to provide a touch screen panel which has a more finished, neat, and low profile appearance.

It is a further object of this invention to provide a method of manufacturing a touch screen panel with an integral wiring harness.

It is a further object of this invention to provide such a method of manufacturing a touch screen panel with an integral wiring harness which eliminates the possibility of damaging the corner electrodes of the touch screen panel and which eliminates the possibility of damaging the touch screen substrate.

It is a further object of this invention to provide such a method of manufacturing a touch screen panel with an integral wiring harness which is less labor intensive and less costly than prior art methods.

This invention results from the realization that a more reliable, less labor intensive, less costly, and more aesthetically pleasing low profile touch screen panel assembly can be effected by an integral wiring harness wherein the prior art individual wires are replaced with conductive traces deposited on an insulative border layer on the panel either by printing or by some other method. The low profile conductive lands provide a more reliable, less expensive, and more aesthetically pleasing touch screen

panel. The insulative border layer electrically isolates the conductive wire traces from the edge electrodes of the touch screen panel.

This invention features a method of manufacturing a touch screen panel. A glass substrate is coated with a resistive layer, a dielectric border layer is deposited on the periphery of the resistive layer, and a pattern of conductive edge electrodes are applied to the resistive layer and typically, at the same time, a conductive wire trace pattern is applied to the dielectric border layer which electrically isolates the wire trace pattern from the edge electrodes printed on the resistive layer.

The resistive layer is typically a tin oxide composition and the glass substrate is typically a soda lime glass composition. The step of depositing the dielectric border layer preferably includes screen printing a lead borosilicate glass composition on the periphery of the resistive layer. The step of applying the pattern of conductive edge electrodes to the resistive layer and the step of applying the conductive wire trace pattern to the dielectric border layer preferably includes screen printing silver/frit paste on the resistive layer to form the edge electrode pattern and screen printing a silver/frit paste on the dielectric border layer to form the wire trace pattern.

The method of this invention may further include the step of applying a protective border layer over the edge electrodes and the wire traces. The protective border layer may be screen printed over the edge electrodes and the wire traces and typically the material used is a lead borosilicate glass composition. In the preferred embodiment the applied edge electrodes, wire traces, the dielectric border layer and the protective border layer are all fired at the same time.

The panel is subjected to an elevated temperature in a first period of time to burn

off any organic material and a dwell period at the elevated temperature to cure the electrodes and wire trace materials and to fuse the border layer material. The elevated temperature is typically between 500°C-525°C, the first time period is approximately 5 minutes and the dwell period is approximately 2-3 minutes.

A touch screen panel in accordance with the subject invention includes a glass substrate with a resistive layer deposited on one surface thereof, a dielectric border layer on the periphery of the resistive layer, a conductive wire trace pattern on the dielectric border layer, and a pattern of conductive edge electrodes on the resistive layer.

The resistive layer is preferably a tin oxide composition and the glass substrate is typically a soda lime glass composition. The dielectric border layer is usually formed from a lead borosilicate glass composition. The conductive wire trace pattern and the conductive edge electrodes are typically formed form a silver/frit paste composition. The touch screen panel of the subject invention may further include a protective border layer over the edge electrodes and over the wire traces. Lead borosilicate glass may be used as the material for the protective border layer.

In another embodiment, the wire trace pattern is placed over the edge electrode pattern and electrically isolated therefrom by a dielectric border layer between the wire trace pattern and the conductive edge electrodes. In accordance with this method, a glass substrate is coated with a resistive layer; a pattern of conductive edge electrodes are printed on the resistive layer, a dielectric border layer is printed over the conductive edge electrode pattern, and a wire trace pattern is printed on the dielectric border layer.

A touch panel in accordance with this embodiment comprises a glass substrate with a resistive layer deposited on one surface thereof, a pattern of conductive edge

electrodes on the resistive layer, a dielectric border layer over the pattern of conductive edge electrodes, and a wire trace pattern on the dielectric border layer.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects, features and advantages will occur to those skilled in the art from the following description of a preferred embodiment and the accompanying drawings, in which:

Fig. 1 is a schematic view of a prior art touch screen panel assembly;

Fig. 2 is schematic view of a touch screen panel just before the dielectric border layer is applied to the resistive coating in accordance with the subject invention;

Fig. 3 is a schematic view of the touch screen panel shown in Fig. 2 after the dielectric border layer is applied to the resistive coating;

Fig. 4 is a schematic view of the touch screen panel shown in Fig. 3 after the pattern of conductive edge electrodes is applied to the resistive layer and the conductive wire trace pattern is applied to the dielectric border layer in accordance with the subject invention;

Fig. 5 is a cross-sectional view of a portion of the touch screen panel in accordance with the subject invention after a protective insulative border layer is applied over the edge electrodes and the wire traces;

Fig. 6 is a graph showing the temperatures and dwell times associated with a step of firing the applied edge electrodes, the wire traces, the dielectric border layer, and the insulative protective border layer in accordance with the subject invention;

Fig. 7 is a flow chart depicting the primary manufacturing steps associated with

making the touch screen panel of the subject invention;

Fig. 8 is a cross sectional view of a touch panel in accordance with another embodiment of the subject invention in which the dielectric border layer is deposited over the edge electrode pattern;

Fig. 9 is a top view of the touch screen panel after the border layer is deposited over the edge electrode pattern but before the wire trace pattern is screen printed thereon; and

Fig. 10 is a flow chart depicting the primary manufacturing steps associated with assembling the touch screen panel shown in Fig. 8.

DISCLOSURE OF THE PREFERRED EMBODIMENT

Prior art touch screen panel 10, Fig. 1, includes substrate 12 which usually includes an insulative layer (e.g., glass), a resistive layer over the primary working surface of the insulative layer, and a pattern of edge electrodes 14 and terminal electrodes, usually corner electrodes 16, on the resistive layer as is known in the art. There are additional corner electrodes (not shown) one at each other corner 18, 20, and 22 of the touch screen. The edge electrodes 14 repeat in some predetermined patterned fashion along each edge 24, 26, 28, and 30 of panel 10.

Wires 32, 34, 36, and 38 extend to each corner electrode and with their ends stripped of insulation are soldered to the respective corner electrodes in order to generate the appropriate electrical field across the working surface 40 of panel 10. So, for example, wire 32 extends along edges 24 and 26 of panel 10 to the corner electrode (not shown) at corner 18; wire 34 extends along edge 24 of panel 10 to corner electrode 16;

wire 38 extends along edges 24 and 30 of panel 10 to a corner electrode (not shown) at corner 20; and wire 36 extends along edge 24 of panel 10 to a corner electrode (not shown) at corner 22. In some prior art embodiments, an electrical tape and then an insulated copper shield layer 44 may be laid between the wires and the edge electrodes and to electrically isolate edge electrodes 14. A hole is then formed in the insulative tape proximate each corner electrode as shown at 46 in order to solder the ends of each wire to the appropriate corner electrode. Alternatively, layer 44 ends just before each corner electrode. In other embodiments, the wires are simply taped to the edges of panel 10. In still other embodiments, tape layer 48 and/or a protective (e.g., "Kapton") tape layer 50 are placed over the wires. Insulated noise shield tape layer 44 may be placed over the edge electrodes and under wires 32, 34, 36, and 38.

In Fig. 1, the thickness and width of border layers 44, 48, and 50 are greatly exaggerated for the purposes of illustration as is the thickness of substrate 12. Actual touch screen panels are usually 1/8 inch thick or less and layers 44, 48, and 50 are substantially thinner than that but still wires 32, 34, 36, and 38 make the completed assembly appear somewhat bulky and unfinished.

Moreover, prior art touch screen panel 10 in some cases is not very reliable because the solder joints between the individual wires and the corner electrodes can fail. Further, the act of soldering the ends of each wire to the corner electrodes can damage the electrodes or even crack the substrate of the touch screen panel. In addition, the assembly process wherein the wires are soldered at their ends to the corner electrodes and taped to the edges of the panel is labor intensive and hence costly..

In the subject invention, in contrast, the wiring is integrated as a part of the touch

screen panel so that there are no bulky wires or layers of tape associated with the touch screen panel as is the case with the prior art.

Touch screen panel 48, Fig. 2 in accordance with this invention is manufactured by applying resistive coating 50 (e.g., tin antimony oxide) by a vacuum sputter process to glass substrate 52 (e.g., soda lime glass). Coating 50 is less than 1000 angstroms thick and substrate 52 is typically between 1-3mm thick and 15 inches on a diagonal.

In this invention step 100, Fig. 7 dielectric border layer 53, Fig. 3 is deposited on the periphery of resistive coating 50 by screen printing a lead borosilicate glass composition 1/8 inch wide and 10 microns thick (after firing) along the edges of panel 48. Border layer 53 provides electrical isolation between the individual wire traces of the wiring harness and electrical isolation between the wire traces and the edge electrodes of the edge electrode pattern.

After dielectric border 53 dries at 120°C for 5 minutes, conductive edge electrode pattern 54, Fig. 4 is then screen printed on resistive coating 50 using a conductive silver/frit paste available from DuPont (No. 7713) and at the same time wire trace pattern 56 is screen printed on border layer 53 also using silver/frit paste, step 102, Fig. 7.

As shown in Fig. 4 wire trace 58 begins at junction 60 and extends along the edge of panel 48 to corner electrode 62 of electrode pattern 54. Wire trace 64 similarly begins at junction 60 and extends along the opposite edge of panel 48 to corner electrode 66 of edge electrode pattern 54. Wire trace 68 begins at junction 60 and extends to corner electrode 70 and wire trace 72 begins at junction and extends to corner electrodes 74 of electrode pattern 54.

The height of each wire trace is typically between 12-16 microns and each trace is

between 0.015" and 0.025" wide.

Edge electrode pattern 54 may take the form of the pattern disclosed of co-pending application Serial No. 09/169,391, or the forms disclosed in U.S. Patents Nos. 4,198,539; 4,293,734; or 4,371,746 hereby incorporated herein by this reference.

Typically the edge electrode pattern and the wire trace pattern occupy only about ⅜ inch on the edges of panel 48 and thus Fig. 4 is not to scale.

After a drying operation at 120°C for 5 minutes wherein the silver/frit paste is dried, an insulative lead borosilicate glass composition (DuPont DG-150) is typically screen printed about the border area of the touch panel over the wire trace pattern and the edge electrode pattern, step 104, Fig. 7. The width of the protective border layer, 86, Fig. 5 is typically ½ inch and it has a height of about 12 microns after firing.

After lead borosilicate glass layer 86 dries at 120°C for 5 minutes, (an optional step) it and the conductive silver/frit paste of the edge electrode pattern, the wire trace pattern and the dielectric border layer are cured by firing at the same time in an infrared oven, step 106, Fig. 7.

During this firing step, the organic binders of the silver/frit paste, the dielectric layer, and the outer borosilicate layer must be allowed to escape the outer layer before the lead borosilicate glass layer fully cures to prevent voids and defects.

Accordingly, in this invention, outgassing is allowed to occur before the peak temperature in an infrared oven is reached whereupon the silver/frit paste is cured and the lead borosilicate glass fully fuses.

As shown in Fig. 6, the preferred firing profile consists of a ramp from room temperature up to 500°C-525°C in approximately 5 minutes in order to complete the

solvent evaporation and burn out the organic binders in the thick film materials. The ramp is followed by a dwell period above 500°C for 2-3 minutes to allow the frit glass to melt and the silver to sinter. The substrate is then brought back to ambient temperature. An additional firing profile may consist of a ramp from room temperature to 300°C with a dwell period between 300-400°C for 6-10 minutes to provide additional time to burn out the organic binders if required. This dwell period is followed by a second ramp to the peak temperature of 500°C-525°C with little or no dwell period. The substrate is then brought back to ambient temperature. Before firing, a separate drying step is performed to evaporate the solvents in the thick film materials. The drying profile consists of a ramp to 120-135°C for a dwell period of 2-6 minutes and then brought back to ambient temperature. The insulative lead borosilicate glass layer advantageously protects the wire traces and the edge electrodes and isolates them from each other. In the prior art, tape was used which was unsightly and often peeled up which left the edge electrodes and the wire traces unprotected. Moreover, by co-firing the paste of the edge electrode pattern and the wire traces, the dielectric border layer, and the lead borosilicate glass protective layer, the separate firing steps of the prior art are eliminated.

After firing, a hard coat and/or anti-microbial, and/or anti-scratch coatings may be applied to the active area of the touch panel (and optionally over the protective border layer) by dipping and/or spraying techniques, step 108, Fig. 7 and, after any of these additional coatings are cured, a wiring harness is attached to junction 60, Fig. 3, step 110 Fig. 7.

In another embodiment of the subject invention, dielectric border layer 53, Fig. 8 is placed over edge electrode pattern 54 to increase the active area of panel 48.

Glass substrate 52 is coated with resistive layer 50 as discussed above and then edge electrode pattern 54 is screen printed on resistive layer 50, step 200, Fig. 10 and allowed to dry. Dielectric border layer 53 is the screen printed over edge electrode pattern 54, step 202 as shown in Fig. 9 leaving gaps or orifices 120, 122, 124, and 126 in dielectric border layer 53 proximate the corner electrodes of edge electrode pattern 54 so that the terminal ends of the wire traces make electrical contact with the corner electrodes. After dielectric border layer 53 dries, wire trace pattern 68, Fig. 8 is screen printed on dielectric border layer 54, step 204, Fig. 10. The terminal ends of the wire traces extend through orifices 120, 122, 124, and 126, Fig. 9 in dielectric layer 53 and make electrical contact with the corresponding corner electrodes of the edge electrode pattern under orifices 120, 122, 124, and 126. As shown at 206, Fig. 10 processing then typically continues in accordance with steps 104, 106, 108 and 110, Fig. 7 and typically protective border layer 86, Fig.8 is applied by screen printing and the assembly is then fired.

Although specific features of this invention are shown in some drawings and not others, this is for convenience only as each feature may be combined with any or all of the other features in accordance with the invention.

Other embodiments will occur to those skilled in the art and are within the following claims:

What is claimed is: